Cultivation of Neglected Tropical Fruits With Promise

Part 6. The Rambutan

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Cultivation of Neglected Tropical Fruits With Promise

Part 6. The Rambutan

By Narciso Almeyda, Simón E. Malo, and Franklin W. Martin[1]

ABSTRACT

The rambutan, *Nephelium lappaceum* L., is a popular fruit of Southeast Asia still practically unknown in the Western Hemisphere. A medium-size tree with an open structure, the rambutan produces panicles of small flowers followed by clusters of ellipsoidal fruits up to 10 cm in length. The fruits are covered by a thick skin bearing flexible protuberances. The skin is easily peeled away, revealing a whitish pulp around a central seed. The pulp is sweet to subacid, translucent, attractive, and suitable for processing. The rambutan is strictly tropical in growth requirements and needs high humidity and a long rainy season. Cultural techniques are discussed. A problem of iron deficiency, which causes chlorosis, makes establishment of seedlings difficult. Improved varieties propagated by grafting are available. The rambutan would be a suitable and popular fruit for Puerto Rico and other parts of the American Tropics. KEYWORDS: botany, fruits, plant cultivation, rambutan (*Nephelium lappaceum*), tropical agriculture (fruits).

INTRODUCTION

The rambutan (*Nephelium lappaceum* L.) is one of the best known fruits of Southeast Asia, where the great majority of the population know it and enjoy it. It is especially important in Thailand, Malaysia, and Indonesia but extends to the east as far as the Philippine Islands. This fruit belongs to the Sapindaceae, a family that includes a number of little-known Asian fruits: *Litchi chinensis* L., the litchi; *Euphoria longana* Lam., the longan; and *Nephelium mutabile* Blume, the pulasan. The litchi is perhaps the best known of these in the Western Hemisphere, particularly in Hawaii and Florida, where the longan is also coming into prominence. The pulasan, although not as well known as the rambutan, is a valuable fruit popular in some regions of Southeast Asia (*3*).[2]

In spite of its almost complete restriction to Southeast Asia, the rambutan can be considered one of the most promising fruits for the humid Tropics. Its introduction and popularization in the Western Hemisphere has been slow for many reasons: the seeds are short lived, the seedlings are difficult to establish, and the young trees grow weakly.

As with many other tropical fruits, the rambutan has a number of characteristics that recommend it for cultivation in the Western Hemisphere. Among these are its remarkable, refreshing flavor, attrac-

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[2]Italic numbers in parentheses refer to items in "References" at the end of this publication.

FIGURE 1.—Rambutan trees in the botanical garden of the University of Puerto Rico, Río Piedras. This planting includes rambutan and mangosteen, *Garcinia mangostana* L.

FIGURE 2.—Rambutan inflorescence (a panicle).

FIGURE 3.—Hermaphroditic flowers of the rambutan.

tive to all, and the exotic appearance of the fruit because of the red and yellow coloring of the flexible hairlike protuberances. The edible part is the aril, which surrounds a single large seed. The aril is white, translucent, and attractive. The texture is firm but juicy. It is an easy fruit to eat. The aril is often canned, either by itself or stuffed with pineapple. It is also used in various conserves. The rambutan is a popular breakfast and dessert fruit, especially in the canned form, and it could be popular on the American market.

THE RAMBUTAN

Botanical Description

The rambutan, as a tree grown from seed, is a medium-size tree, reaching 8 to 10 m in height (fig. 1). The principal trunk is erect and straight with an open crown of large branches. The bark is slightly rugose, grayish or reddish. Grafted plants, however, are much smaller, 3 to 5 m in height, and have a more dense crown. Leaves are alternate and compound, with two to four pairs of leaflets and a terminal leaflet. The leaflets are elliptic to ovoid, shiny dark-green above and clearer and opaque below. The blade is thin but coriaceous, smooth, and from 5 to 10 cm in length by 2 to 10 cm in width.

Inflorescences are much branched, axillary or borne as terminal panicles (fig. 2). The flower does not have a corolla, but the calyx is entirely green, covered with a fine pubescence and divided into four to six lobes. Three kinds of flowers have been observed. Male flowers are characterized by a polygonal disk from which five to eight stamens arise, each 3 to 4 mm in length. The female flowers are composed of a circle of staminoids surrounding a central pistil with a bifid style. Perfect flowers combine the male and female parts (fig. 3). Cultivated varieties are generally monoecious, that is, with male and female flowers on the same plant. Dioecious seedlings are also known.

The fruit is an ovoid drupe produced in panicles of

FIGURE 4.—Panicle of developing fruits.

FIGURE 5.—Rambutan branches, flowers, and fruits.

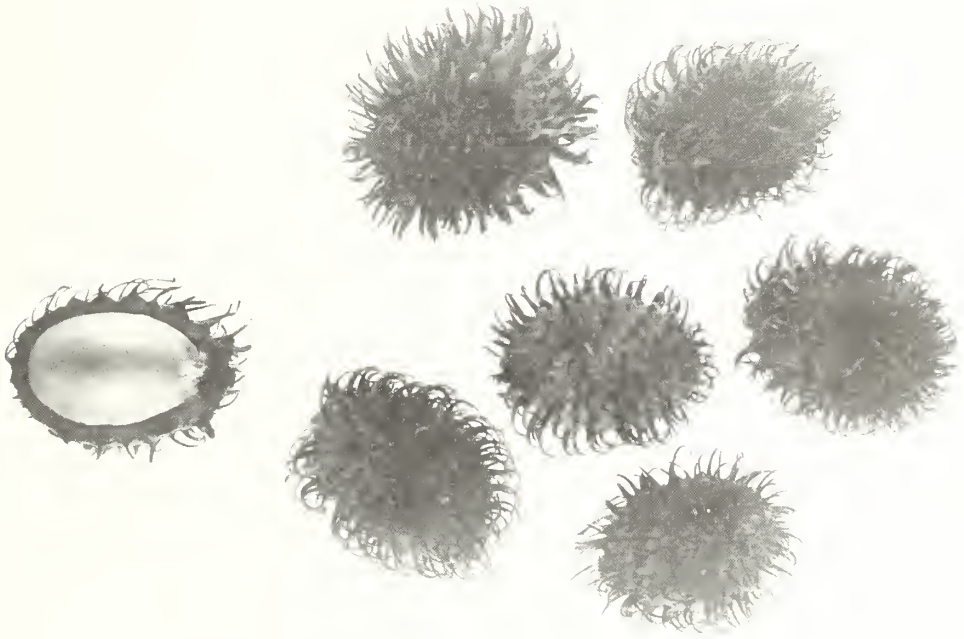

FIGURE 6.—Rambutan fruits. Observe the protuberances on the surfaces of the fruits.

10 to 20 fruits (fig. 4). Fruits are from 3 to 8 cm in diameter and 2 to 4 cm in width, and weigh 50 g or more. The exterior of the fruit varies in color from light green to pale yellow, rose, or wine red. Usually, highly colored fruit will have red, yellow, and green intergrading with each other. The surface is further characterized by numerous flexible protuberances from 6 to 15 mm in length (fig. 5). Although these protuberances give a hairy appearance to the fruit, they are thick and fleshy. The word "rambutan" has been derived from the Malayan word "rambut," which means hair, in direct reference to the appearance of the fruit. The white, translucent aril, or pulp, measures 5 to 8 mm in thickness (fig. 6). The seed is ellipsoidal, 2 to 3 cm long, yellowish green to brown, and it consists chiefly of two large cotyledons. The pulp tends to be attached to the seed in some varieties,

FIGURE 7.—Rambutan seedlings in 4-l plastic bags.

but free-aril varieties are known and are in high demand (*4*, *5*, *9*, *10*).

ORIGIN

The rambutan is native to the Malaysian-Indonesian region, where it is still seen in its wild form in the forests of the Malay Peninsula and where it is known by many native names for the tree as well as the fruit. The rambutan is seen most frequently in Thailand, Malaysia, and Indonesia, where excellent varieties are propagated by grafting. It is found to some extent in all countries of the humid Asian Tropics (*1*, *2*, *6*).

Although the rambutan has probably been introduced to all countries of the Tropics, it is usually little known outside Southeast Asia. In the Western Hemisphere, trees are often seen in botanical gardens and private collections. In Puerto Rico, some trees that bear well are growing in the botanical garden of the University of Puerto Rico in Río Piedras, where they thrive among plantings of mangosteen (*Garcinia mangostana* L.).

VARIETIES

The named varieties of rambutan are numerous, but their nomenclature is confused. Frequently, the same common name is used for several varieties, or the same variety is known by different names. The only reliable identification of varieties has come from collections and comparative yield tests. In Southeast Asia, superior varieties are now available from reliable nurserymen.

Perhaps the best study of varieties is that by Whitehead (*15*), who observed a varietal collection in Malaysia over a long period. He mentions a pre-World War II collection of 144 selected varieties that was lost. Eleven of the most important varieties are described (table 1). Fifteen varieties are described by Sastrapradja in Indonesia (*11*), but these are only a few of the many available (table 1).

In Thailand, the most popular varieties, such as 'Rongrien' and 'Chompu', have a crisp aril that is well adapted for canning and fresh consumption. 'Rongrien' (meaning school in the Thai language) was discovered as a seedling in the grounds of small country school in southern Thailand. It is the most popular variety with the people. 'Chompu' (meaning pink) is a favorite with growers because of its capacity for large crops.

CULTIVATION

SOIL AND CLIMATIC REQUIREMENTS

The rambutan is a tree of the tropical forest and thus suitable for areas of high rainfall over a fairly long season. It is strictly tropical in its requirements and is seldom successful in the subtropics. The rambutan is found in different tropical soils and seems not to be particular about its soil requirements. It is at its best in deep soils with a good content of organic material, a slightly acid reaction, and good drainage. In Southeast Asia, it does well on recently cleared hillsides or in areas converted from forest to farm and used only for a few years (*12*). In Puerto Rico, the rambutan has grown fairly well in heavy soils. All fruit trees need well-drained soils.

Although the rambutan is frequently seen with mangosteen, it is much less capable of withstanding poor drainage. Therefore, it is advantageous to plant the rambutan where there is a natural slope facilitating drainage.

In sandy soils, the rambutan needs some organic matter in order to grow naturally.

PROPAGATION

Seeds

A large number of rambutan trees now in production throughout Southeast Asia originated from seed. This is not the desirable method of propagation nor the method used by commercial nurseries, because plants from seeds vary, and many seedlings produce poor fruits. In addition, seedlings vary in sex, as previously explained. Male trees are practically useless, and female trees, unless well polli-

TABLE 1.—Important rambutan varieties and their sources and characteristics

Variety	Country	Fruit characteristics	Free aril?	Use
'Atjeh'	Indonesia	Medium spines, sweet, juicy		
'Atjeh hurung'	do	Red, long spines, subacid, juicy		
'Atjeh kuning'	do	Yellow, sweet, rather juicy		
'Ayes Mas'	Malaysia	Yellow, medium aril, sweet	Partial	Fresh.
'Azimal'	do	Yellow to crimson, thick aril, sweet to subacid	Yes	Do.
Bara'	do	Crimson, medium aril, acidic	No	Do.
'Bingjai'	Indonesia	Green, long spines, ellipsoidal, sweet		
'Chompu'	Thailand	Pink to light red in color, medium size, fair quality, sweet	Partial	Fresh, canning.
'Chooi Ang'	Malaysia	Pink to red, thick aril, subacid	Yes	Fresh.
'Gelong'	Indonesia	Globose, long spines, subacid, juicy		
'Gendut'	do	Green, medium spines, ellipsoidal, sweet		
'Gulabatu'	do	Greenish yellow, long spines, globose		
'Kelip'	Malaysia	Crimson, medium aril, sweetish	Partial	Fresh.
'Kepala Besar'	do	Yellow to crimson, aril medium, sweet	do	Fresh, canning.
'Kering manis'	Indonesia	Green, almost globose, long spines		
'Lebak bulus'	do	Subacid, juicy		
'Lengkeng'	do	Green or yellow, globose, very short spines, very sweet		
'Maharlika'	do	Dark red, rather small fruit, very sweet, melting aril, excellent quality		
'Penang'	Thailand	Large size, fair quality, tends to have two seeds per fruit, sweet	Partial	Do.
'Peng Th'ng Bee'	Malaysia	Crimson, medium aril, sweet	Yes	Fresh, canning.
'Pd. bulan'	Indonesia	Medium spines, globose		
'Rapiah'	do	Green or yellow, very sweet, small		
'Rongrien'	Thailand	Medium to large in size, fair quality, crispy aril, sweet	No	Fresh.
'Seematjan'	Indonesia	Light red to orange in color, medium sized, sweet	No	Do.
'Seenjonja'	do	Dark red, small to medium size, fair quality, sweet	Partial	Do.
'Singapura'	Malaysia	Light orange to scarlet, thin aril, sweetish	do	Do.
'Sitang-kue'	Indonesia	Ellipsoidal, medium spines, sweet		
'Tau Po Cheng'	Malaysia	Orange-scarlet, thick aril, subacid	Yes	Fresh.
'Triang'	do	Dark red, thick aril, sweetish	No	Do.
'Ya Tow'	do	Scarlet, thick aril, subacid	Partial	Fresh, canning.

nated, do not bear well. Populations of seedlings of rambutan have yielded up to 67 percent males. Propagation from seed should only be used for the development of new varieties. To preserve good, hermaphroditic varieties, vegetative propagation is necessary (*14*).

Seeds, when removed from the fruits, have a short lifetime. It is desirable to maintain them slightly moist and to plant them in 2 or 3 days. After 2 weeks, germination is erratic, and many of the trees that originate from such seeds are weak. After 3 or 4 weeks, seeds usually do not germinate.

Seeds can be established in carefully prepared seedbeds or in individual containers (fig. 7). The latter method is preferred, for it eliminates the risks of transplanting, and the plant remains in better condition for transplanting to the field. In seedbeds, a good mixture for germination is 75 percent peat moss and 25 percent perlite. This medium is slightly acid. In the Philippines, the recommended mixture is equal parts of clean river sand, composted manure, and a loam soil. Compared to plants grown in other mixtures, plants grown in this mixture show the best vigor and growth in height, number of leaves, and stem diameter, as well as general appearance (*8*).

The seed is planted horizontally with a small portion exposed at the surface of the soil. Germination occurs between 10 to 20 days. Young seedlings should be partially shaded to avoid damage from excess sunlight.

A limiting factor in the growth of the rambutan is its susceptibility to iron deficiency, which produces chlorosis (yellowing of the leaf). The chlorotic plant is weak and susceptible to diseases and pest attacks. Even adult plants may be chlorotic. If chlorotic plants produce fruit, it is usually deficient in quality and quantity. For normal growth, the rambutan needs a slightly acid soil, pH 5.0 to 6.5, but even under this condition chlorosis often appears. Chlorosis has been a limiting factor in the production of the rambutan in the Western Hemisphere, and it has also been seen throughout tropical Asia, especially in soils that lack sufficient iron or that are slightly alkaline.

To prevent iron deficiency in young plants, the use of Sequestrene 138 chelate (CIBA-Geigy FE EDDHA) is recommended. About 10 g of Sequestrene is dissolved in 4 l of water and applied directly to the soil around the young tree, making sure the chelate gets down to the roots. This treatment should begin early in order to avoid chlorosis. Once chlorosis has occurred, it is difficult to correct it.

Vegetative propagation

Vegetative propagation is indispensable for production of trees of high quality. Trees produced in this fashion tend to come into fruiting at a younger age than seedlings and are usually smaller and broader as well. Vegetative propagation also insures that the sex of the tree is preserved.

The rambutan is grafted most successfully by the modified Forkert method. This technique consists of making two vertical cuts in the trunk of the seedling stock at the level where the graft is to be placed (15 to 20 cm from the soil level). The cuts are 3 cm in length and 1 cm apart. A horizontal cut is made between the first two cuts, and the strips of cortex are lifted to expose the wood of the stock. A branch of the selected variety of the same size as the stock with swollen but not well-developed buds is selected. With a sharp knife, a bud is carefully removed with its wood. This piece should be the same size as the area prepared on the stock. The wood is carefully removed from the bud piece, and only the cortex with bud is inserted into the space prepared. As the bud piece is placed in the stock, the two flaps of cortex of the stock are placed over the bud. The bud is tied firmly in place with rubber or plastic strips to protect them from drying out and to unite the cambial tissues of stock and scion.

After 20 to 25 days, the rubber or plastic is removed, and the graft is inspected. If the bud is viable, the seedling is partially cut through, somewhat above the graft, and the trunk is bent over or doubled to stimulate growth of the bud. When the scion has developed 30 to 45 cm of growth, it is tied to a stake, and the stock is cut 2 cm above the graft. New growths from the stock are eliminated when they occur (*7*, *13*).

Experiments in Malaysia have demonstrated that mature budwood (9 months old or more) is superior to young budwood as a source of vigorous buds. In addition, removal of leaves from the budwood 14 days before grafting is essential to stimulate the growth of new buds. Vigorous stocks 3 to 5 months of age, timed to be grafted near the beginning of the rainy season, are the most successful. When conditions are optimum, up to 90 percent success has been achieved.

Another method, used for material difficult to graft and suitable for the rambutan, is the approach graft. It is simple, and a higher percentage of success is generally had than with other grafting methods. In approach grafting, the scion as well as the stock retain their roots until the graft has taken (*13*). Thus, the health and strength of the scion is

preserved during the process. In the most common version, the top of the stock is cut away at the moment of grafting.

The process consists of growing the stocks in black plastic bags in a medium that contains coconut fiber, perlite, and peat moss and that does not weigh more than 280 to 340 g. A branch that has a diameter similar to that of the stock is selected. The crown of the stock is cut away, leaving only 13 to 15 cm of bare stock. This cut is in the form of a wedge that is inserted into a superficial cut in the cortex of the scion, which is made from below. The stock and scion are carefully tied with rubbers or plastic strips.

One month after being grafted, the branch of the selected variety, the scion branch, is ringed somewhat below the point of grafting. The ring of cortex removed should be about 2 cm wide. After 1.5 to 2 months, the scion is cut free from the parent trunk, lightly pruned, and transplanted to a larger container, 5 to 8 l in capacity. These are carefully protected and hardened for a few weeks until transplanted to the field.

Another common propagation method is the marcot, one of the most ancient grafting techniques. Depending on the rambutan variety, it is often successful. In this method, roots are formed on branches that have been ringed, covered with moist moss, and protected with plastic. Marcots are easy to make and do not require special ability or major training. Fairly large plants are produced in a short time. Nevertheless, there is a limit to the number that can be produced from a single tree, and the percentage of failure will sometimes be high.

The method consists of the selection of terminal branches 2 to 3 cm in diameter 60 to 80 cm from the tip. Two circular cuts are made around the branch, about 3 cm apart. The band of cortex between the cuts is removed, and the area is filed or scraped to remove the cambium and prevent healing or regrowth. The ring is covered with a suitable dampened medium, generally sphagnum moss, and covered with plastic or aluminum sheeting. Aluminum has the advantage of ease of application but is often damaged by birds, permitting the moss to dry out. Plastic sheets are useful and permit some passage of air.

Several months are needed for the development of roots. The cover may be carefully removed for inspection and to dampen the medium. When a ball of roots is formed, marcots are cut from the trees, pruned, planted in large containers in partial shade, and carefully cared for until well established.

Transplanting

The rambutan should not be planted in areas with less than 2,000 cm of rain yearly, or with a long or strong dry season. The area to be planted should be prepared well in advance of transplanting. Trees, shrubs, vines, and weeds should be eliminated, as well as large stones, old fences, or foundations and other obstacles. The individual sites for the trees should be carefully cleaned in circles about 2 m in diameter. If other crops are to be planted among the young trees, the land should be plowed and disked.

Distance between plants should be carefully selected, because this affects cultivation and other operations, as well as the production of the trees. The rambutan produces its fruit near the periphery of the crown. If two trees touch, the area of fruit production is reduced. The correct distance between trees depends on the quality and depth of the soil. Other factors that influence the optimum distance are the growth habit of the particular cultivar, the topography, and the arrangement available for irrigation. An average spacing of 10 m between trees is recommended (*10*). In fertile soils, this distance must be increased. In level plantings, the most used system for planting is the square technique (plants in rows and rows spaced equally). In hilly regions, planting by the contour is recommended, and space between trees will not be uniform.

Once the distance between trees and the method of alining them are defined, the next step is marking the areas. Holes for planting should be large enough to accommodate the bagged tree, with space to spare. A reasonably sized hole is 45 cm in diameter and 45 cm deep. In less fertile soils the holes should be larger so that extra compost or manure can be added. In Puerto Rico, composted filter press cake from sugar mills has given excellent results, if the organic material is well mixed with the soil. In addition, 250 g of mineral fertilizer such as 8–8–8 should be mixed with the soil.

Planting techniques for the rambutan are the same as with other fruit trees. The trees should never be bare rooted (planted without a ball of soil). Normally, the seedlings will be in polyethylene bags, which must be carefully cut away just before planting, because these bags do not decompose in the soil and may permanently impede root growth. If in cans, care should be taken to cut the metal and eliminate the can without damaging the roots. When the ball of soil is placed in the hole, it should be located so that the soil level of the original con-

tainer corresponds to the level of the planted tree. The soil added below and around the tree should be firmly compacted to avoid air bubbles. This soil ought to be dampened, if not already moist, so that it compacts well and so that irrigation water can enter freely. A watering basin about 1 m in diameter should be constructed around each tree.

The preferred planting time is the beginning of the rainy season when soil moisture is adequate and when favorable rains can be expected for a long period. In Puerto Rico and most parts of the Caribbean, the recommended planting season is June and July.

Irrigation

Immediately after planting, the tree and the soil around it should be thoroughly watered (25 to 40 l per tree). Thereafter, the trees will require careful attention, especially if there is not sufficient rain.

There are a number of good alternatives for watering trees. At planting and for a few weeks thereafter, it might be convenient to water with a tank mounted in a cart, for the plants will be widely spaced, and only the areas around the plants will need water. Where there is abundance of water and field labor, watering by small irrigation canals might be feasible. The canals must be carefully designed to flow by gravity and to fill the watering basins of each tree. Irrigation by sprinklers is costly but is now often used because it requires a minimum of hand labor. This method requires the installation of special equipment, including expensive pumps that should give a minimum pressure of 50 lb/in^2 (3.5 kg/cm^2), PVC irrigation tubing, aluminum or steel sprinkler heads, and professional design of the irrigation system.

A new method, drip irrigation, has become popular because of its low cost, low water use, and easy installation. Water is conducted through tubing at 15 to 20 lb/in^2 (1 to 1.4 kg/cm^2), and is distributed to each tree slowly by means of a constant drip. The quantity of water delivered is 8 to 24 l per hour, depending on the number of drippers, but the system is flexible and can be adjusted to the needs of the orchard. Orchards irrigated with this system always retain the correct degree of soil moisture.

Fertilization

During growth and especially during production of fruits, adequate quantities of nutrients are needed. It is a general practice now to use mineral fertilizers or manures to supply the elements seldom present in soil in sufficient quantities for adequate growth and production. The elements most necessary for the majority of fruits are nitrogen (N), potassium (K), and phosphorus (P). The rambutan responds during its first 5 years of growth to a fertilizer with equal proportions of N, P, and K, such as 6–6–6 or 8–8–8, expressed as percentage. After 5 years, trees need less phosphorus but more nitrogen and potassium. Nitrogen is the element that disappears most rapidly from the soil, but it must be present for continuous use. It is difficult to make specific recommendations, for soils vary greatly in amounts of nutrients.

The rambutan, as most fruit trees, should be fertilized almost from the moment that the seed germinates. In seedbeds, the trees should receive a dilute solution of soluble fertilizer 20–2–20 with microelements (zinc, copper, iron, magnesium, and so forth) mixed as 1 g/l water. This solution should be applied each week to the foliage and to the soil. When the trees are transferred to plastic bags, mineral fertilizer can be applied at the rate of 10 g per bag of about 8 l of soil, well mixed into the soil. This fertilizer should be added again to the bags each 2 months until the trees are transplanted.

Fertilization of the soil at the time of transplanting has been mentioned. Each 3 months during the first year, 100 g of 6–6–6 or 8–8–8 mineral fertilizer should be applied. Thereafter, the number of treatments can be reduced to three a year, and the amount of fertilizer given increased gradually to 250 g per application. After the fifth year, only nitrogen or potassium are given, once or twice a year.

The area below the crown of young trees should be cleaned of weeds before fertilization and should be maintained weed free. The fertilizer is applied by manual scattering around the basin area of the tree. Subsequently, it is desirable to water the trees well so that the fertilizer enters the soil.

Pruning and Care

As with other trees that bear fruit near the periphery of the crown, the rambutan needs only a minimum of pruning. Grafted trees tend to grow in a low spreading fashion and need little pruning. Pruning should be done only to remove dead or broken branches or those few that are badly formed (*13*). A well-formed tree should have a wide crown with the principal branches well separated, and the interior should be free of suckers and dry or diseased branches.

The planting of cash crops or green manure crops among the young trees can be beneficial, but such

crops should not be planted too near the trees, lest they compete with them for nutrients. Legumes with low growth habits such as *Crotalaria*, *Vigna*, *Canavalia*, and *Pueraria* can be used. Ground covers that are viny must be watched so that they do not climb the trees. Once the rambutan trees have occupied more than half the room allotted to them, the production of cash crops should be terminated. Cover crops or some grasses can grow between the trees if they are not too vigorous and are cut once in a while to reduce competition with the trees.

Frequent weedings are necessary especially during the rainy season. At the beginning of the dry season, the area below the tree can be covered with a mulch of dried plant materials to reduce water loss.

DISEASES, INSECTS, AND OTHER PESTS

The most serious disease affecting the rambutan is a fungus, *Oidium* sp., which attacks the flowers. In Southeast Asia, this fungus appears from January to March during the dry season when the trees begin to flower. The most serious insect pest in the American Tropics is the sugarcane root borer, *Diaprepes abbreviatus* L. (fig. 8). It is a beetle with a triangular head, a body 1.27 to 1.90 cm long, covered with striped scales of various colors. This insect is common throughout the Caribbean and attacks almost all crops. The adult feeds on leaves of many kinds, and when it finds a kind it especially likes, it will return night after night to feed. Females deposit their eggs on the leaves where the larvae hatch, fall to the ground, and enter the soil, where they feed on roots (*16*).

Several types of scales (fig. 9) have been encountered on rambutan trees in Puerto Rico, but these do not now seem to be serious enough to recommend treatment.

Perhaps the most serious problem with the rambutan is damage caused by rats, which often eat a small amount of pulp and thus make the entire fruit unmarketable. Rats can be controlled with approved poisons mixed in a bait such as flour and placed in feeding stations around the trees. The poison needs to be available continuously to be effective. Rats are also controlled by sheet-metal shields around the trunk at least a meter from the soil. These must be flexible, for trunks continue to grow. If rats cannot enter the trees from the ground, other plants, or buildings, the fruit can be saved.

The rambutan fruit is well protected by its soft spiny cortex and can be transported to market in boxes or handled with a minimum of injury.

FIGURE 8.—Damage to rambutan leaves caused by adult sugarcane root borers, *Diaprepes abbreviatus* L.

FIGURE 9.—Scales attacking rambutan leaves. At this intensity of attack, no control is necessary.

HARVEST

If the trees have been well cared for, the production should be abundant. Trees from seeds need 5 to 6 years to fruit, but grafted trees can fruit in 3 to 4 years and reach maximum production at 8 to 10 years after planting. The majority of the varieties of Southeast Asia fruit from July to October, with perhaps a smaller crop from December to February, depending on the distribution of rainfall. In Puerto Rico, a single crop is produced, generally from November to December.

Few reliable data are available on the yields of rambutan trees, because yields differ greatly with variety, place, and season. Normal yields vary from 25 to 200 kg per tree, and an average yield is about 130 kg. Productive trees tend to produce heavy crops one year and light crops the next. Compared with other fruit trees of the family *Sapindaceae*, litchi and longan, the rambutan is the most productive and the least variable.

Rambutan fruits usually mature together on the raceme. The entire raceme is cut with a suitable knife or hook mounted on a long pole. Care should be taken to avoid damage to the branches, for they are the sources of the fruit of the following year. If the individual fruits are removed from the raceme, they should each have a peduncle attached.

During the havest and afterwards, the fruit should be treated carefully to avoid bruising or excessive exposure to the sun. After harvest, it is advisable to sort the fruit for degrees of ripeness and to remove those that are damaged or deformed.

USES

The fruit of the rambutan is used chiefly as a fresh dessert fruit. It is easily opened either with the fingers or with a superficial cut with a knife, and the cortex and its protuberances are easily peeled away. The white pulp (aril) is separated from the seed in the case of the free-aril varieties. The pulp is sweet or subacid and often faintly agreeable aromatic. It is pleasing to all even when tasted for the first time. Its chief nutritional content is vitamin C, and it has a high sugar content.

Several kinds of jams and jellies are made from the fresh fruit. The aril is also canned in a light sirup as whole fruits or stuffed with pineapple. The processing of the fruit, although resulting in delightful new products, results in loss of much of the exquisite quality of the fresh fruit. Industrial use of the fruit has permitted extension of the season and the development of a thriving canning industry in Thailand and Malaysia.

Other uses of the rambutan are as ornamental trees for backyards and for public streets. The tree is beautiful, especially when in full fruit. The leaves, roots, and bark are used in folk medicine.

RESEARCH NEEDS

Unlike many of the fruits from Southeast Asia, the rambutan is not ready for wide distribution in the Western Hemisphere. Although individual trees and small groves exist, the problem of establishing young trees is so serious that it must be studied and resolved before an industry can develop. It is believed that studies of the influence of soil (type, pH, aeration, drainage), soil amendments (mosses, perlite, lime, mineral fertilizers), and environmental influences (shading, humidity), will provide the information necessary to establish rambutan seedlings.

To make the rambutan a success, it will be necessary to bring large quantities of seeds from Southeast Asia and propagate and distribute them widely. Improved varieties are necessary and can be obtained either by importing existing varieties or by selecting new varieties among local seedlings. New varieties can then be propagated as seedlings. Rapid air transportation now makes introduction on a large scale feasible.

Although a few trees are available in Puerto Rico, and will continue to be made available each year, the rambutan cannot be successfully developed in spite of its high promise until the necessary research steps are taken.

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